Order Up!

Reporting Category	Computation and Estimation
Topic	Exploring the order of operations and using it to evaluate numerical expressions

Materials

- Poster board
- Markers
- Order of Operations recording sheet (attached)
- Number cubes
- Calculators

Vocabulary

expression, area (earlier grades)

order of operations, parenthesis, exponents, evaluate (6.8)

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Prior to the lesson, draw on poster board three rectangles with the following dimensions: 9 by 5, 9 by 8, and 9 by 4. Make sure the rectangles are large enough for students to see during a class discussion. Draw the square units on the rectangles; then, cut out the rectangles.

1. Review with students the process of finding the area of rectangles.
2. Display the three rectangles you made, and write the dimensions under each one. Have students find the area of each rectangle and then share their answers.
3. Combine any two rectangles (e.g., the 9 by 4 and the 9 by 5), and ask students to find the area of the combined rectangles. Allow students time to work, and then have them share their answers. Put the two rectangles together, and have students count the squares to verify the total area.
4. Focus students' attention on the two separate rectangles making up the combined rectangle. Ask them how they can use the areas of each rectangle to find the combined area. After students share their thoughts, write: $9 \times 4 + 9 \times 5$. Ask students how to solve this expression to get the answer 81. Ask them whether they can solve it in any order or whether there is one order that must be used. This should lead students to describe completing the multiplication steps first and then doing the addition.
5. Extend the activity by combining all three rectangles to solve for the total area. Lead students in writing the steps to find the area, using the order of operations. Tell students that they are using the *order of operations.* Explain that the order of operations is a convention that defines the computation order to follow in evaluating an expression.
6. Share the order of operations with students, writing them on chart paper as you go. Make it clear to students that multiplication does not always come before division, nor does

addition always come before subtraction. Use this discussion to make sure students understand the meaning of exponents. You may want students to write the order of operations in their math journals for future reference.

7. Model evaluating an expression, using the order of operations. Write the expression $(4 + 5) \cdot 4 - 3^2 + 9 \cdot 2$ on the board. Make sure students understand that the dot (·) is a symbol for multiplication that was represented with "x" (as in 3 x 4) in previous grades. Have them try following the order of operations on their own to find a value for the expression. Then, have them share their answers.
8. Model how to find a value for the expression, as shown below:

$$
\begin{aligned}
&(4 + 5) \cdot 4 - 3^2 + 9 \cdot 2 \\
&\mathbf{9} \cdot 4 - 3^2 + 9 \cdot 2 \\
&9 \cdot 4 - \mathbf{9} + 9 \cdot 2 \\
&\mathbf{36} - 9 + \mathbf{18} \\
&\mathbf{27} + 18 \\
&\mathbf{45}
\end{aligned}
$$

9. Give students other expressions to evaluate by bringing the next step down and continuing to solve until a value results.
10. Have student pairs play an order of operations game, as follows:
    - Give each student an Order of Operations recording sheet, and give each pair of students a number cube.
    - Have players take turns rolling the number cube six times and recording the rolled numbers in the blanks for Round 1 on the recording sheet. Players should record their opponents' rolls as well. Players may place their numbers in any blanks for that round, but they may not move a number to another blank once it has been placed.
    - Once all blanks are filled for Round 1, have players evaluate their expressions and their opponents' expressions, using the order of operations. Make sure students show each step of simplifying the expressions. Players should compare their answers. The player with the greatest value wins a point for that round.
    - The game continues in this manner until players have completed five rounds. The player with the most points after five rounds wins the game.
11. After students have finished the game, have the whole class discuss any strategies that were used to win points. Ask students to discuss how the game would be different if there were no order of operations.

Assessment

- **Questions**
    - What is the significance of the order of operations?
    - What would happen if people did not use the order of operations?
- **Journal/Writing Prompts**
    - Write a story to illustrate the importance of sequencing in your everyday life.
    - Describe why using the order of operations is important.
- **Other**
    - Use the Order of Operations recording sheet as an assessment.

Extensions and Connections (for all students)

- Put random rational numbers on the board, and have students use them to make their own expressions.
- Have students use only the number 4, the operation symbols, and knowledge of the order of operations to make an expression for each of the target numbers 1 through 12. For example, an expression for the target number 20 could be $(4 + \frac{4}{4}) \cdot 4$.
- Divide students into groups, and give each group a number. Have the group derive an expression for which the given number is the answer.
- Discuss with students other types of things that must happen when doing a process in sequential steps. Talk about what might happen if the steps were not followed in the proper order. Relate this to the order of operations.

Strategies for Differentiation

- Provide students with the order of operations written out to use throughout the lesson.
- Allow students to use a calculator when completing activities throughout the lesson.
- Share the mnemonic device PEMDAS with students as a way to remember the order of operations:

P	Parenthesis
E	Exponent
MD →	Multiplication *or* division from left to right
AS →	Addition *or* subtraction from left to right

Order of Operations

Name _____ **Date** _____

Round	Player 1	Player 2	Point
Example	(___ + ___) · ___ − ___^{2} + ___ · ___ Rolls: 3, 3, 4, 4, 1, 1 (3 + 3) · 4 – 4^2 + 1 · 1 **6** · 4 – 4^2 + 1 · 1 6 · 4 – **16** + 1 · 1 **24** – 16 + **1** **8** + 1 **9**	(___ + ___) · ___ − ___^{2} + ___ · ___ Rolls: 3, 2, 4, 1, 1, 6 (3 + 2) · 4 – 1^2 + 1 · 6 **5** · 4 – 1^2 + 1 · 6 5 · 4 – **1** + 1 · 6 **20** – 1 + **6** **19** + 6 **25**	Player 2
1	___ · ___ + ___ + ___ · ___ + ___	___ · ___ + ___ + ___ · ___ + ___	
2	(___ + ___) · (___ + ___) − ___ + ___^{2}	(___ + ___) · (___ + ___) − ___ + ___^{2}	
3	___ · ___ · ___ ÷ ___ + ___ − ___	___ · ___ · ___ ÷ ___ + ___ − ___	
4	___ · (___ + ___ + ___ + ___) · ___	___ · (___ + ___ + ___ + ___) · ___	
5	(___ · ___ · ___ − ___) ÷ ___ + ___^{4}	(___ · ___ · ___ − ___) ÷ ___ + ___^{4}	